Timer-Counters

PM 6670...72

Operating Manual

PHILIPS

Important
As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Please note
In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Contents

Printed in Sweden

1. Technical Specification

Measuring modes

Frequency

Range: 0.1 Hz...120 MHz (PM 6670, 6671). 0.1 Hz...1 GHz (PM 6672).

Mode: Input-signal synchronized, high resolution computing measuring method (reciprocal).

Signal mode: CW, SINGLE BURST, MULTIPLE BURST FREQUENCY AVERAGE. In the FREQUENCY AVERAGE mode (rear panel selectable), the counter measures the average of a multiple of frequency samples. Samples are taken with external gate control (≥500 ns) and totalized during the selected measuring time (10 ms...96 s) to allow multiple burst frequency measurements or to sample frequency sweep profiles.

LSD displayed: 10^{-7} Hz...10^{3} Hz (PM 6670, 6671). 10^{-7} Hz...10^{4} Hz (PM 6672), depending on measuring time and input frequency. At least 7 digits displayed per second of measuring time.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm \frac{\text{resolution}}{\text{FREQ}} \pm \frac{\text{trigger* error}}{\text{measuring time}} \pm \text{rel. time base error.}$$

Period average

Range: 100 ns...100 s

LSD displayed: 10^{-15}...10^{-6} s, depending on measuring time and period duration. At least 7 digits displayed per second of measuring time.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm \frac{\text{resolution}}{\text{PERIOD}} \pm \frac{\text{trigger* error}}{\text{measuring time}} \pm \text{rel. time base error.}$$

Time interval A to B ; single

Range: 100 ns...10^{8} s.

LSD displayed: 10^{-7} s...10^{0} s.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\frac{\pm \text{resolution} \pm \text{trigger* error}}{\text{TIME INT}} \pm \text{rel. time base error.}$$

Pulse width A

Pulse width measurements are similar to single time interval measurements. Both start and stop triggering take place in channel A, with common trigger level setting and automatic trailing edge trigger slope inversion with respect to selected leading edge trigger slope.

All other specifications are identical to single time interval. High resolution, pulse-width measurements on narrow pulses can be made in the time interval average mode with manual selection of common source and stop slope polarity.

Time interval A to B ; average

Range: 0 ns...100 s.

LSD displayed: 10^{-15} s...10^{-6} s, depending on measuring time and time interval.

Resolution:

$\frac{10^{-7}\text{s}}{\sqrt{N}}$ or, 1 LSD unit, whichever is greather.

Inaccuracy (rel. error):

$$\pm \frac{4\text{ ns} \pm \text{resolution}}{\text{TIME INT}} \pm \frac{\text{trigger* error}}{\sqrt{N} \times \text{TIME INT}}$$

± rel. time base error.

Number of intervals averaged (N): Measuring time x interval repetition rate.

Minimum dead time from stop to start: 300 ns.

Note: Input signal must be repetitive and asynchronous with respect to the time base.

Count A

Totalize range: 1...10^{17}, with indication of M-pulses and G-pulses beyond the 10^{8} display range.

Pulse pair resolution: 80 ns.

Mode:

Manual: Start-stop by DISPL. HOLD push button. Sequential start-stop periods are accumulated or individually totalized after reset.

External: Totalizing interval controlled via input B, selectable: count A gated during pulse duration on B or count A gated between start and stop pulse on B.

Inaccuracy: Pulse repetition rate A x trigger* error B.

Phase A—B

Phase is the result of a simultaneous time interval average and period average measurement. The maximum phase range is therefore limited, due to the 300 ns dead time between stop and start of the next time interval, and consequently frequency dependent. For phase measurements between 180° and 360° on high frequency signals, it is recommended to measure the complementary phase 0°...180° by changing the input leads (phase B to A).

Phase range: 0.1°...360° x |1-(300 ns x FREQ)|;

Example 0.1°...359.995° at 50 Hz
0.1°...357.3° at 25 kHz
0.1°...180° at 1.666 MHz

Frequency range: 0.03 Hz...1.6 MHz

LSD displayed: 10^{-6}...10^{-2} degrees, depending on measuring time and phase difference.

Resolution: $\frac{10^{-7}\text{s} \times \text{FREQ} \times 360°}{\sqrt{N}}$

Inaccuracy (rel. error):

$$\pm \frac{4\text{ ns} \times 360° \times \text{FREQ}}{\text{PHASE}} \pm \frac{\text{resolution}}{\text{PHASE}} \pm \frac{\text{trigger* error} \times \text{FREQ} \times 360°}{\sqrt{N} \times \text{PHASE}}$$

Number of input cycles averaged (N): Measuring time x FREQ A.

Minimum input signal: 100 mV_{rms}.

Phase jitter tolerance: The tolerated phase jitter peak-value ≤ phase difference, i.e. phase jitter around 0° should not cause consecutive measurement results of slightly above 0° and slightly below 360°, since the toltal measurement result is the statistical average of all individual results.

Ratio

Range:

$$\frac{\text{FREQ A}}{\text{FREQ B}} = \frac{0...10\text{ MHz}}{0...10\text{ MHz}} \text{(all models)}$$

LSD displayed: 10^{-7}...10^{0}

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm \frac{\text{resolution}}{\text{RATIO}} \pm \text{rel. trigger* error B.}$$

Note: Frequency ratio measurements

$$\frac{\text{FREQ A (or C}^{**}\text{)}}{\text{FREQ D}} = \frac{0.01\text{ Hz}...120\text{ MHz (or 1 GHz}^{**}\text{)}}{50\text{ kHz}...10\text{ MHz}}$$

can also be made in the frequency mode, by making use of the external reference input D. However, this arrangement does not give correct decimal points.

** C only on PM 6672.

RPM

The RPM (revolutions per minute) mode is similar to the frequency mode. The measured frequency is multiplied x 60, before being displayed.

Range: 0.6 RPM...10^{8} RPM (with one pulse per revolution).

LSD displayed: 10^{-7} RPM...10^{0} RPM, depending on measuring time and RPM.

Resolution: LSD*.

Inaccuracy (rel. error):

$$\pm \frac{\text{resolution}}{\text{RPM}} \pm \frac{\text{trigger* error}}{\text{measuring time}} \pm \text{rel. time base error.}$$

* see definitions.

Input and output specifications

Inputs A and B

Frequency range:

DC coupled: 0...120 MHz

AC coupled: 50 Hz...120 MHz

Rise time: Approx. 4 ns.

Sensitivity:

DC coupled: 10 mV_{rms} sine wave or 30 mV_{pp} (0...75 MHz). 20 mV_{rms} sine wave or 60 mV_{pp} (75...120 MHz).

AC coupled: 10 mV_{rms}...100 mV_{rms} sine wave (50 Hz...75 MHz). 20 mV_{rms}...100 mV_{rms} sine wave (75...120 MHz).

Attenuation: x 1/x 10 fixed.
For frequency related measurements, the fixed attenuator can be used in combination with the continuously variable attenuator x 1...x 10 (AC coupled position).

Noise immunity/hysteresis band:

DC coupled: approx. 20 mV_{pp}/200 mV_{pp}.

AC coupled: approx. 20 mV_{pp}...2 V_{pp}.

Dynamic input voltage range:

DC coupled: 30 mV_{pp}...5 V_{pp}/ 300 mV_{pp}...50 V_{pp}.

AC coupled: 10 mV_{rms}...2 V_{rms}/ 100 mV_{rms}...20 V_{rms}.

Trigger level:

DC coupled: −2.5 V...+2.5 V/ −25 V...+25 V.

AC coupled: fixed 0 V; level control acts as continuously variable attenuator, which is more suitable for frequency related measurements.

Trigger level output, not available on PM 6670: Set trigger voltages −2.5 V...+2.5 V, available on 1 mm jacks at the front for monitoring of set trigger level.

Trigger indicators, not available on PM 6670: Tri-state LED trigger lights to indicate trigger status:

On: trigger level is too low.

Blinking: triggering occurs, input signal crosses hysteresis band.

Off: trigger level is too high.

Coupling: DC/AC.

Impedance: Approx. 1 MOhm//35 pF, independent of sep/com switch position.

Channel input: Separate A and B or common A.

Noise filter: Switchable 50 kHz Low pass filter in channel A. Noise suppression approx. 40 dB at 1 MHz.

Maximum voltage without damage:

DC: 300 V.

AC: 260 V_{rms} at ≤440 Hz declining to 12 V_{rms} at ≥1 MHz (in ATT x 1 position), 260 V_{rms} (in ATT x 10 position).

Input C, PM 6672 only

Frequency range: 70 MHz...1 GHz.

Operating input voltage range:
15 mV_{rms}...12 V_{rms} (70 MHz...800 MHz).
25 mV_{rms}...12 V_{rms} (800 MHz...1 GHz).

Impedance: 50 Ohm nominal; VSWR <2.

Coupling: AC.

AM tolerance: 98%, minimum signal must exceed minimum operating input voltage.

Maximum voltage without damage: 12 V_{rms}; overload protection with PIN diodes.

Ext. reference and Ratio input (channel D),
not available on PM 6670

Frequency range: 1 kHz...10 MHz.

Sensitivity: 500 mV_{rms}.

Impedance: Approx. 2 kOhm.

Coupling: Ac.

Max. voltage without damage: 25 V_{rms}.

Note: As external reference frequency, only 10 MHz will give correct decimal point and unit indication. With the optional frequency multiplier PM 9697 references of 1 and 5 MHz can also be accepted.

Internal standard output (channel D),
not available on PM 6670

Crystal frequency: 10 MHz.

Output level: LS-TTL compatible.

Output impedance: Approx. 400 Ohm.

Coupling: DC.

Overload protection: Short-circuit proof.

Ext. arming/Freq-avg/ Reset (channel E),
not available on PM 6670

A 3-position rear panel switch gives choice of external control over:

ARMING: In this position, the counter is prevented from starting a new measurement when input E is high. A high-to-low going pulse arms the counter to start a new measurement.

Note: Arming not applicable in COUNT A, manual mode.

FREQUENCY AVERAGE: Frequency measurements (max. 100 MHz) and period measurements are interrupted when input E is high. The measurement is continued again when input E is low. Each individual frequency sample must contain at least 20 pulses (FREQ mode) or 2 pulses (PERIOD mode).

The effective measurement time (defining resolution and accuracy) is the sum of external gate times that occurs during the selected measurement time.

EXT. RESET—START: Electrical reset, equivalent to the front panel RESET pushbutton. (See HOLD and RESET). Counter is reset when input E goes high. A new measurement can be made after input E has returned low.

Input levels:

High: ≥2 V.

Low: ≤0.5 V.

Input impedance: Approx. 2 kOhm.

Max. input voltage without damage: ±25 V.

Minimum pulse duration:

Arming and frequency avg: 500 ns.

External reset: 200 µs.

Gate monitor output (rear),
not available on PM 6670

The gate status monitor output permits observation on an oscilloscope of the measured time interval and the trigger hold-off time (PM 6671 only).

Output level:

Main gate open: approx. 0.4 V.

Hold-off active: approx. 1.2 V.

Main gate closed: approx. 2.5 V.

Output impedance: Approx. 1.5 kOhm.

Delay: Internal delay between actual triggering and gate monitor output is approx. 150 ns.

Overload protection: Short circuit proof.

Auxiliary functions

Measuring time

The measuring time is "continuously" variable (33 steps/decade): 10 ms...96 s, with clear setpoints at 10 ms, 100 ms, 1 s, 10 s and 96 s. Selected measuring time is displayed, without any delay, when depressing the measuring time control.

The actual measuring time equals the selected measuring time plus the time needed to synchronize the measurement with an integer number of cycles of the input signal (Reciprocal measurements are synchronized with multiples of 10 input cycles).

In the FREQUENCY AVERAGE mode, the measuring time can be externally controlled to make burst frequency average measurements.

Hold-off PM 6671 only

With trigger hold-off activated, the counter ignores re-triggering (channel A) or stop triggering (channel B) during the set hold-off time. The hold-off time can be digitally measured by pressing CHECK. Applicable in all time modes.

Range: 200 µs...200 ms, in period, time interval and pulse width mode, the set hold-off time is visible with CHECK depressed.

On/off indication: LED indicates when hold-off is activated.

Monitor: The selected hold-off duration can be made visible via the gate monitor output.

On Stand By

In "ST BY" position, power is available to maintain an ovenized crystal oscillator heated and to recharge the optional battery pack.

Check

10 MHz internal reference connected to logic circuitry. Self-test of most measuring functions can be selected. By using this mode, the COUNT function provides a stop-watch facility.

Display hold

Depressing "DISP HOLD" button sets display time to infinite and freezes the last measurement result. A new measurement can be initiated using reset.

In the COUNT mode, the "DISP HOLD" control is used to start and stop manual totalizing.

Reset

Manual via pushbutton or electrical via input E.

General

Display

Read out: 8 digits, 7,6 mm high-efficiency LED's. Microprocessor control of display format, decimal point and unit indication: Hz, kHz, MHz, GHz, ns, µs, ms and s.

Display time: Continuously variable 80 ms...96 s plus DISP HOLD.

Gate lamp: Indicates that main-gate is opened and measurement takes place.

ST BT: Stand-by indication with LED when instrument is not switched ON.

REMOTE:** Indicates when control over counter is taken by the installed BUS interface option (IEC 625 – IEEE 488).

Low-battery:** Indication by blinking display some 15 min. before recharging is needed.

Power requirements

In addition to the normal line voltage supply, the PM 6671 and PM 6672 can also be powered from an optional battery pack or external DC voltage.

Line: 115/230 V ± 15%; 45...440 Hz; <25 VA.

Internal battery unit:** PM 9693.

External DC Cource:**
Voltage: 11.8 V...28 V; 4.5...8 W depending on version and options installed.
Connector: Battery jack fitting DIN 45323.

Line interference: Below VDE 0871 (B) and MIL STD 461.

Safety: According to IEC 348 and CSA 556 B.

** not available on PM 6670.

Dimensions and weight

Width: 210 mm (8.25 in).

Height: 89 mm (3.8 in).

Depth: 280 mm (11.0 in).

Weight:
Net: approx. 2.5 kg.
Shipping: approx. 3.6 kg.

Environmental conditions

Temperature:
Rated range of use: – 5°C...+50°C.
Storage and transport: –40°C...+70°C.

Humidity:
Operating: 10...90% RH, no condensation.
Storage: 5...95% RH.

Altitude/Barometric pressure
Operating: 5000 m (15000 ft) – 53.3 kN/m².
Storage: 15000 m (50000 ft) – 15.2 kN/m².

Vibration test: According to IEC 68 Fc.

Bump test: According to IEC 68 Eb.

Handling test: According to IEC 68 Ec.

Transport test: According to NLN-L88.

Definitions

LSD displayed

Unit value of Least Significant Digit, displayed.

For FREQUENCY, PERIOD AVERAGE, RPM and PHASE:

$$\text{LSD} = \frac{2.5}{\text{measuring time}} \times \frac{\text{FREQ or PERIOD or RPM or } 360°}{10^7\,\text{Hz}}$$

For RATIO: LSD =

$$= \frac{2.5 \times \text{prescaling factor (P)} \times \text{RATIO}}{\text{measuring time} \times \text{FREQ A or C}}$$

(P) = 1 Channel A, all models
(P) = 256 Channel C, PM 6672.

For SINGLE TIME INTERVAL and PULSE WIDTH:

LSD = 100 ns (for times <10 s).

$$\text{LSD} = \frac{5 \times \text{TIME}}{10^8} \text{ (for times} \geq 10\,\text{s).}$$

For TIME INTERVAL AVG: LSD =

$$= \frac{2.5 \times 10^{-7}\,\text{s}}{\text{meas. time} \times \text{time int. rep. rate in Hz}}$$

All calculated LSD's shall be rounded to nearest decade (e.g. 5 ns will be 10 ns and 0.4 Hz will be 0.1 Hz) and cannot exceed the 8th digit.

Resolution

For multiple event measurements:

FREQUENCY, PERIOD AVERAGE, RPM and RATIO, the resolution is the smallest increment between two measuring results being most often 1 LSD unit. Due to arithmetic truncation, the resolution can be 2 LSD units if:

$$\frac{\text{LSD} \times \text{measuring time}}{\text{FREQ or PERIOD or RPM or RATIO}} < 10^{-7}\,\text{s}$$

but can then be reduced to 1 LSD unit, by doubling the measuring time.

For single event measurements:

PULSE WIDTH and SINGLE TIME INTERVAL, the measuring resolution is 100 ns (one clock pulse). The counter can accumulate up to 10^{15} clock pulses, of which only the 8 most significant digits are shown.

For statistical measurements:

TIME INTERVAL AVERAGE and PHASE, the measuring resolution is the smallest increment between two measuring results, with confidence level of 95%.

Trigger error

Trigger error is the absolute measurement error due to noise on the input signal causing a too early or too late triggering.

For any waveform (FREQ, PERIOD, RATIO, RPM and PULSE WIDTH):

$$\frac{\text{peak-to-peak noise voltage}}{\text{signal slope (V/s)}}$$

For sinewave (FREQ, PERIOD, RATIO, RPM):

$$\frac{1}{\text{FREQ} \times \pi \times \text{S/N ratio}}$$

Example: For S/N ratio of 100 (40 dB) and 1 second measuring time, the trigger error is: $\frac{3 \times 10^{-3}}{\text{FREQ}}$

For separate source TIME INTERVAL:

$$\frac{\text{peak noise voltage (input A)}}{\text{signal slope A (V/s)}} \pm \frac{\text{peak noise voltage (input B)}}{\text{signal slope B (V/s)}}$$

For PHASE:

$$\frac{1}{\text{FREQ} \times 2\pi} \times \left[\frac{1}{\text{S/N ratio (input A)}} \pm \frac{1}{\text{S/N ratio (input B)}}\right]$$

Note: S/N ratios calculated with peak-to-peak signal and noise values.

Accessories

Supplied with the instrument:

- Line power cord
- Fuse, 1.6 A fast-blow
- Front cover
- Manual

To be ordered separately:

PM 9678: TCXO, 1×10^{-7}/month. Included in version /02.

PM 9679: Proportionally oven controlled oscillator 1×10^{-7}/month. Included in version /03.

PM 9690: Proportionally oven controlled oscillator 1.5×10^{-9}/24 h. Included in version /04.

PM 9691: Proportionally oven controlled oscillator 5×10^{-10}/24 h. Included in version /05.

PM 9693: Battery unit.

PM 9694: BCD output and display offset unit.

PM 9695: Analog recorder output (DAC).

PM 9696: IEC625/IEEE488 BUS interface.

PM 9483/50: IEEE-to-IEC adapter.

PM 9487/10: IEEE cable, 1 m.

PM 9487/20: IEEE cable, 2 m.

PM 9487/40: IEEE cable, 4 m.

PM 9697: External reference frequency multiplier.

PM 8923: 120 MHz, 1 Mohm probe set, 1:1 and 1:10.

PM 8943: 650 MHz, 50 ohm/1 Mohm FET probe set, 1:1-10-100.

PM 9639: 1.5 GHz, 500 ohm probe set 1:10.

PM 9581: 50 ohm feed-through termination, 1 W.

PM 9585: 50 ohm feed-through termination, 3 W.

PM 9074: Coaxial cable, 50 ohm, BNC to BNC, 1 m.

PM 9588: Set of 15 coaxial cables, 50 ohm, BNC to BNC.
5 cables (20.7 cm), 4 cables (40.5 cm), 3 cables (60.3 cm), 3 cables (198.6 cm).

PM 9669/01: 19" rack mount adapter to fit one instrument.

PM 9669/02: 19" rack mount adapter to fit two instruments.

PM 9672: Carrying case.

NOTE: The timebase oscillators, PM 9678, -79, -90 and -91, can also be ordered separately for later upgrading of the counters. The counters can not simultaneously be equipped with more than one of the following options: PM 9693, PM 9694, PM 9695 and PM 9696. The multiplier PM 9697 can only be installed simultaneously with the /01 oscillator. In /02.../05 versions the oscillator must be removed before a PM 9697 can be plugged in.

2. Installation Instructions

General information

This counter has been designed and tested in accordance with IEC Publication, Safety Requirements For Electronic Measuring Appartus For Class 1 Instruments, and has been supplied in a safe condition. The present manual contains information and warnings that shall be followed by the user, to ensure safe operation and to retain the counter in a safe condition.

Before connecting the counter to the line (mains), visually check the cabinet, controls, connectors, etc, to ascertain whether any damage has occurred in transit. If any defects are apparent, do not connect the counter to the line. All components on the primary side of the line transformer are CSA approved and should only be replaced with original parts.

In the event of obvious damage, missing parts or if the safety of the counter is suspected, a claim should be made to the carrier immediately. A PHILIPS sales or Service organisation should also be notified in order to facilitate the repair of the counter.

Grounding

The counter is connected to ground via a three-core line cable, which must be plugged into a socket outlet with a protective ground contact. No other method of safety grounding is permitted for this counter. When the counter is brought from a cold to a warm environment, condensation may cause a hazardous condition. Therefore, ensure that the grounding requirements are strictly met.

Any interruption of the protective ground, inside or outside the counter is dangerous. Line extension cables must always have a protective ground conductor.

Opening of the cabinet

The counter shall be disconnected from all voltage sources before it is opened. If adjustment or maintenance of the counter with the covers removed is inevitable, it shall be carried out only by a qualified person, who is aware of the hazard involved. Bear in mind that capacitors inside the counter may still retain their charge, even if the counter is disconnected from all voltage sources.

Opening of the cabinet or removing of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals that can be dangerous to life.

Line voltage setting

Before connecting the counter to the line, ensure that it is set to the local line voltage. On delivery, the counter is set to either 115V or 220V, as indicated on the line voltage selector on the rear panel. If the voltage setting is incorrect, set the line voltage selector in accordance with the local voltage, before connecting the counter to the line.

External battery operation

(PM 6671 and PM 6672)

For field applications, PM 6671 and PM 6672 can be operated from an external 11.8...28V_{DC} supply, connected to the EXT BATT socket.

Connecting the counter to both the line and an external battery at the same time, gives a power back-up facility that maintains heating of the oven oscillator and recharges the optional internal battery pack PM 9693 when fitted.

Fuses

The counter is protected by a thermal fuse, located in the line transformer and a secondary fuse, 1.6A fast-blow (not PM 6670) on PCB U1. Remove the line plug before fitting a fuse. Ensure that only fuses of the specified type are used. If the counter is set for operation on 115V line voltage, but is connected to a 220V supply, the thermal fuse will blow immediately to protect the counter.

Type	Service code number
Thermal fuse	4822 252 20007
1.6A fast-blow fuse 5x20mm	4822 253 20022

Operating position

The counter can be operated in any desired position. A fold-down tilting handle can be rotated and locked in several fixed positions by first depressing the knob in the centre of each hinge.

Front cover

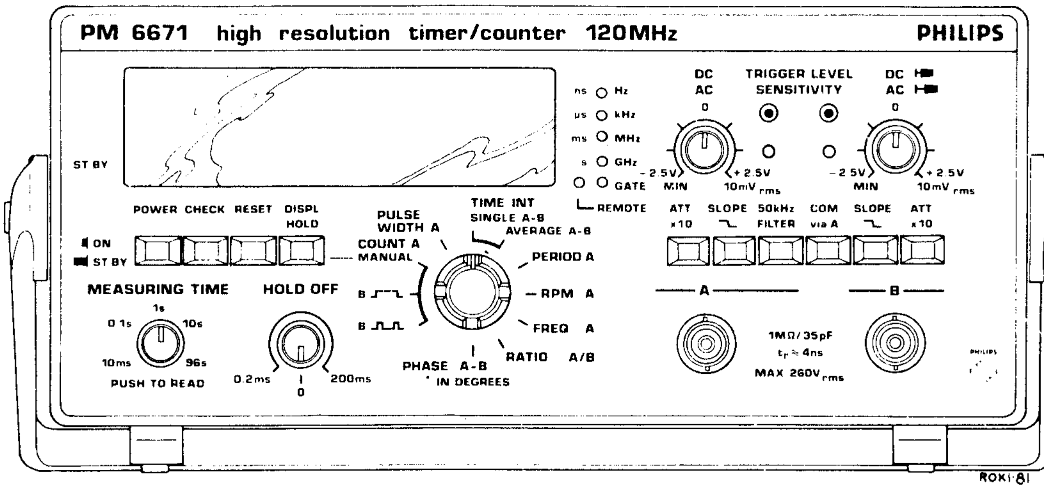
The front panel controls and connectors can be protected by a plastic snap-on front cover.

Cleaning the counter covers

The top and bottom covers, lacquered with sùede coating, need special treatment if the surface gets soiled. The 3M Company has developed a "Doodle-bug Pad" (Catalog No. 8440) which when soaked in water, ethanol or common household cleaning agent, will penetrate holes and pores to restore its former lustre.

Abrasive cleaning pads will result in surface scratches. Although the Nextel sùede coating is ethanol resistant, it is susceptible to methylated spirit, which could damage the surface due to one of the denaturing substances present.

3. Operating Instructions



FRONT PANEL

POWER

Supplies power to the counter in the ON, depressed position. In the ST BY, released position, the counter is switched off, but power is still available for an optional oven oscillator and a rechargeable battery. A decimal point marked ST BY indicates the stand-by mode.

This is a secondary power switch. Even in the stand-by mode the counter contains live conductors and parts. The line cord (mains lead) must be removed to disconnect power from the counter.

CHECK

When depressed, the internal 10MHz standard signal is connected to the logic circuits. In conjunction with the function selector rotary switch, CHECK enables a self-test of most measuring functions.

RESET

When depressed, resets the counter and blanks the display. On release, RESET initiates a new measurement.

DISPL HOLD

When DISPL HOLD is depressed, the display time is set to infinity. A new measurement can be initiated with the RESET push-button.

MEASURING TIME
PUSH TO READ

The measuring time can be set between 10ms and 96s for optimum resolution and measuring speed.

When pushed, the set measuring time is displayed.

HOLD OFF, PM6671 only

During the set hold-off time, the counter ignores all input events that should have ended the measuring cycle. To display the set hold-off time, select TIME INT SINGLE A-B and press CHECK.

Function selector rotary switch

RPM A

Sets the counter to perform a revolution per minute measurement on the signal connected to input A, provided that the transducer sends one pulse per revolution.

FREQ A
FREQ A or C, PM6672 only

Sets the counter to perform frequency measurements on the signal connected to input A or input C. In the frequency average mode, rear panel selectable on PM6671...72, the counter measures the average of several frequency samples, controlled by an external gate signal via Input E.

RATIO A/B

Sets the counter to measure the ratio between signals connected to input A and B up to 10MHz. To obtain full frequency range on PM6671...72, a ratio measurement can be done in the FREQ A or C mode by using input D set to EXT STD IN. However, this method does not give correct setting of the decimal point.

PHASE A–B

Sets the counter to measure the phase (in degrees) between signals connected to input A and B. Max frequency is 1.6MHz. The sensitivity knob should be pulled and set fully clock-wise. The ATT x10 push-button should be released.

COUNT A MANUAL

Sets the counter to totalize events (pulses or periods) on input A during the time interval between releasing and depressing the DISPL HOLD push-button. An event is defined as a positive-going slope.

The result can be accumulated with another count sequence or reset with the RESET button.

COUNT A ⎍ Gated by B

The counter will totalize events on input A, between the leading and trailing edge of the input B signal.

COUNT A ⎍⎍ Start and Stop by B

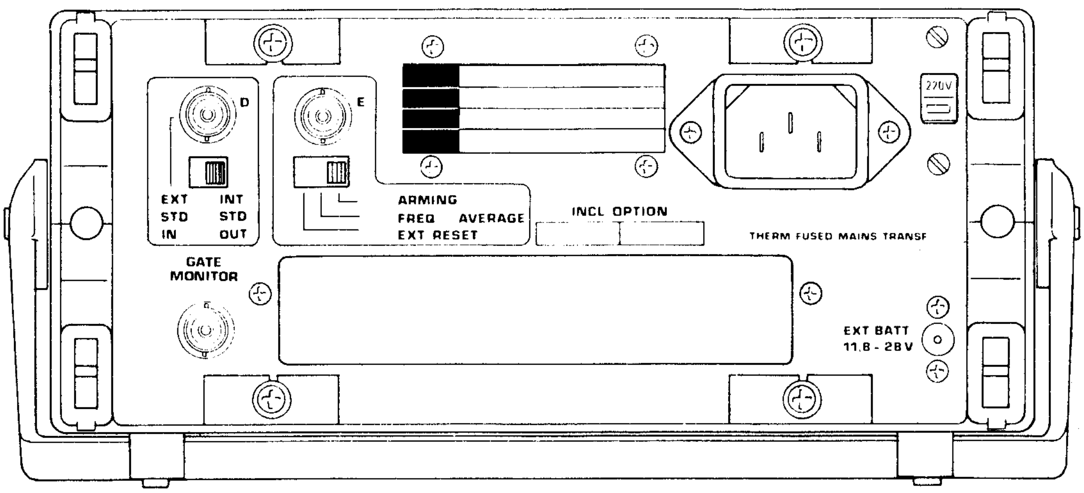
The counter will totalize events on input A, between the start and stop event on input B.

PULSE WIDTH A

Sets the counter to measure the pulse-width of the signal connected to input A.

TIME INT SINGLE A–B

Sets the counter to measure the time interval between pulses on input A and B.



TIME INT AVERAGE A–B

Sets the counter to measure the time interval average of a repetitive signal that is not synchronized with the used standard frequency.

PERIOD A

Sets the counter to measure the average period time of the signal connected to input A.

Input amplifier

ATT x10

When depressed, the sensitivity is attenuated by a factor 10 for input A or B. In DC mode the equivalent trigger level is multiplied by 10.

SLOPE ⌐L

When depressed, the triggering occurs on the trailing edge instead of the normal leading edge.

50kHz FILTER

A low-pass filter to improve triggering of noisy signals with frequencies below 50kHz. Applies to input A only.

COM via A

Connects channel A and B internally. In this mode input B is disconnected.

TRIGGER LEVEL

When the rotary knob is depressed, the DC mode is selected and the trigger level is adjustable between – 2.5V and + 2.5V.

Tri-state trigger indicators on PM6671...72 light to indicate trigger status:

On = trigger level is too low
Blinking = triggering occurs, i.e. input signal crosses hysteresis band
Off = trigger level is too high

The trigger level output on the front panel of PM6671...72 makes it possible to measure the set trigger level.
When ATT x10 is depressed, the trigger level is adjustable between – 25V and + 25V, but the output level is still – 2.5V... + 2.5V.

SENSITIVITY

When the rotary knob is pulled, the AC mode is selected and the sensitivity is adjustable between approx 10...100mV$_{RMS}$

1GHz, PM 6672 only

When depressed, input C is connected. The sensitivity is adjusted automatically.

LED indicators

REMOTE

Indicates that the counter is in the remote-controlled mode via the optional Bus Interface PM9696.

GATE

Indicates that a measurement is in progress.

UNIT INDICATOR

A multi-purpose 4-LED unit indicator.

For FREQ read: Hz, kHz, MHz, GHz.

For PERIOD, TIME and PULSE WIDTH read: ns, µs, ms, s.

For COUNT read: µs/kHz = 10^3 pulses
ms/MHz = 10^6 pulses
s/GHz = 10^9 pulses

REAR PANEL

EXT STD IN/INT STD OUT
Input D

Two-position switch selection of using BNC connector D either as an output for the internal 10MHz standard signal or as an input for an external standard signal.

ARMING/FREQ AVERAGE/EXT RESET
Input E

Three position slide switch for selecting the functions of input E.

GATE MONITOR

Enables observation of the measured time interval and the trigger hold-off time on an oscilloscope.

EXT BATT

Input from an external DC source 11.8...28V.

Theory of Measurements

Introduction

The microcomputer-based PM 6670...72 provide a wide range of frequency and time measuring functinons, including period average, time interval average as well as three count modes. Resolution down to 10ps is possible with time interval average. In addition, these timer/counters offer pulse width measurements, phase delay directly in degrees and tachometer readings i RPM.

PM 6670...72 feature automatic truncation of digits and automatic calculation of displayed LSD (Least Significant Digit). Only significant digits are displayed and no overflow can occur, except for RPM measurements.

A block diagram is shown in Fig. 3.1. To identical channels are used for accurate time interval measurements.

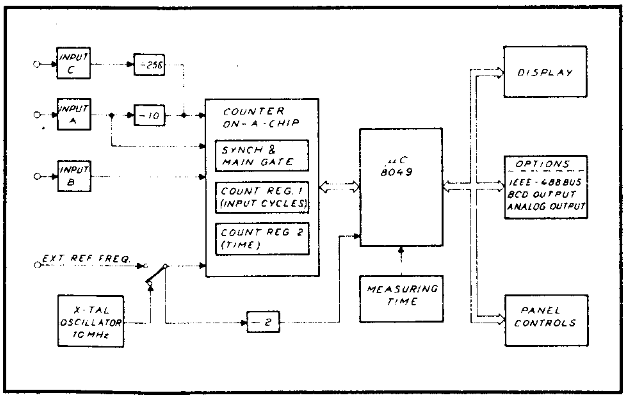


Fig. 3.1. Block diagram

Input triggering functions

As the input signal can have very different wave forms, it is necessary to pulse shape the signal. Ohterwise, the counting circuits could not handle the signal. The input circuits consist of:

- AC/DC-coupling selector;
- an input step attenuator (x10), to attenuate excessive input signals to fit the ± 2.5V trigger level off-set range;
- a switchable low-pass filter for noise rejection;
- a differential amplifier that allows trigger level setting;
- trigger circuits with variable hysteresis band;

The functional difference between AC- and DC-coupled input is illustrated in Fig. 3.2.

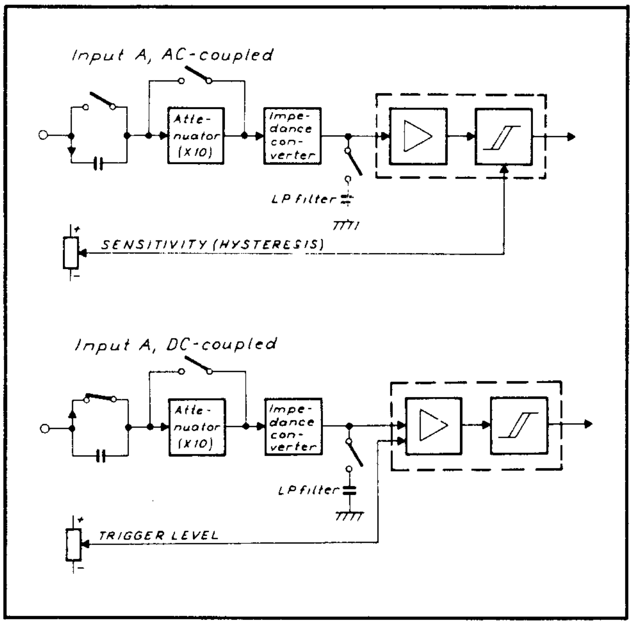


Fig. 3.2. Block diagram of the input circuits.

In AC-coupled mode, which is the normal case for frequency measurements, the trigger level/sensitivity potentiometer controls the Schmitt-trigger sensitivity. In combination with the x10 attenuator, this enables a variable trigger hysteresis band, thus a variable input sensitivity (variable noise immunity). This is essential for correct triggering for frequency measurements of noisy signals.

In DC-coupled mode, which is the normal mode for time measurements, the trigger level/sensitivity potentiometer controls the differential amplifier. This results in a continuous variable trigger level setting. The Schmitt-trigger sensitivity is not influenced, but is set to minimum. It is of utmost importance to have as narrow hysteresis band as possible for time measurements.

Schmitt-trigger function

The Schmitt–trigger function is illustrated in Fig. 3.3.

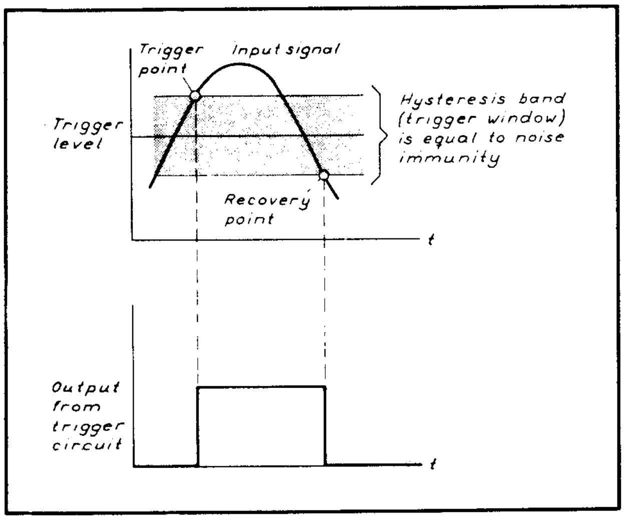


Fig. 3.3. Visualization of the trigger function.

The hysteresis band (trigger window) is centered around the trigger level and the width of the hysteresis band at the input, is the same as the effective input sensitivity of Vpp.

Frequency measurements

Timer/counters are used for both frequency and time interval measurements. However, frequency and time interval measurements have contradictory requirements in respect of correct triggering.

For frequency measurements, too narrow a hysteresisband, i.e. too high a sensitivity, means that the counter is too sensitive to noise; see Fig.3.4. The hysteresis band is equal to noise immunity.

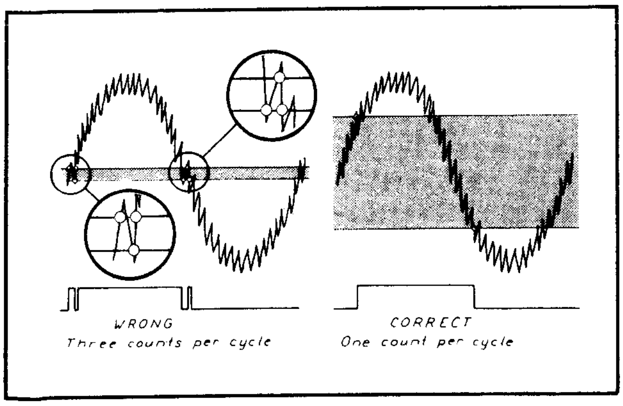


Fig. 3.4. Do not use a higher sensitivity than needed for correct triggering.

The ideal hysteresis band is 50-60% of the signal's peak-to-peak value. Since input signals can have any amplitude within the specification, a continuously variable input attenuator is prefered.

Signals, that are superimposed on a DC voltage, need to be separated via a capacitor, i.e. AC-coupling. The advantages of AC-coupling are:

- No DC drift.
- Good protection against DC overload.

However, AC-coupling gives a drop in sensitivity for very low frequencies.

Time interval measurements

For time interval measurements, too wide a hysteresis band, i.e. too low a sensitivity, means that different signal slopes at the start and stop trigger point, cause different delays between the trigger level crossing and the trigger point, see Fig. 3.5.

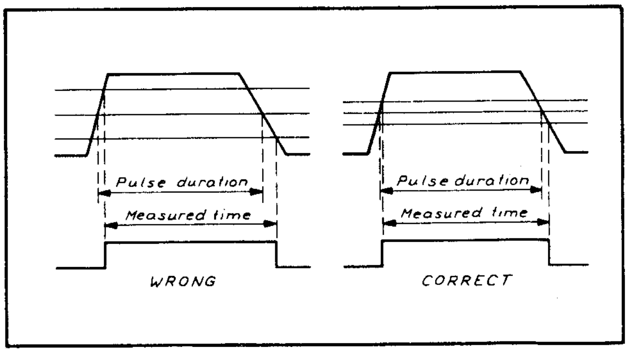


Fig. 3.5. Too wide a hysteresis might cause incorrect time interval measurements.

The highest possible sensitivity with low noise is ideal. However, a calibrated input attenuator is needed to enlarge the trigger level setting range. A separate x10 step attenuator, which expands the trigger level range to -25V... + 25V is available on PM 6670...72.

A continuously variable setting of the trigger level is necessary for setting the trigger level at any required point of the input signal.

If the duty factor of the input signal changes, the average DC-component will also change. In case of AC-coupling, the trigger level follows the average DC-component. This is not acceptable if the time interval measurements with accurate trigger level settings are to be made. Hence, DC-coupling is necessary. Two identical inputs and slope selection are also necessary.

The low-pass filter

The built-in 50kHz low-pass filter is used for improved triggering on noisy LF-signals. The filter characteristic is shown in Fig. 3.6. It is also possible to use this filter for signals with frequencies above 50kHz, but at a reduced sensitivity.

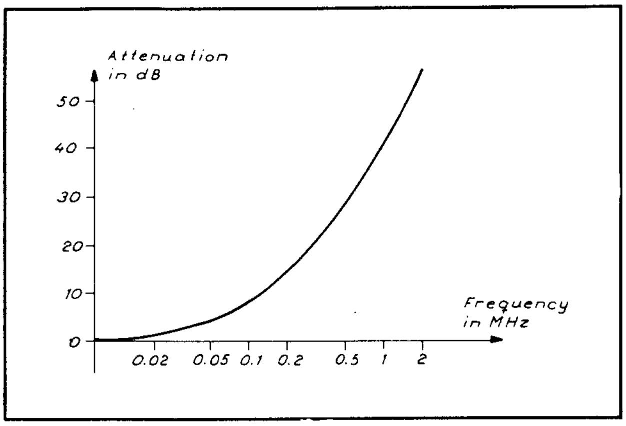


Fig. 3.6. The low–pass filter reduces noise and interference.

Input C

PM 6672 has a special RF input, called input C. Note that not more than $12V_{RMS}$ is allowed at input C and that the input sensitivity is adjusted automatically.

MEASURING MODES

Frequency A, Period A and RPM

PM 6670...72 perform a frequency and period measurement as given in the definitions:

$$\text{Frequency} = \frac{\text{Number of cycles}}{\text{Time}}$$

$$\text{Period} = \frac{\text{Time}}{\text{Number of cycles}}$$

The counter:
1. Measures the effective measuring time.
2. Counts the number of input cycles during the measuring time.
3. Computes the number of cycles per second (frequency) or time units per cycle (period).

The measurement is synchronized with the input signal. This is called the input synchronized or reciprocal method.

In the input synchronized mode, both the opening and closure of the main gate is synchronized with the input signal, so that only completed input cycles are counted. This means that a ±1 input cycle error is avoided. During the gate time, the counter also totalizes the number of 100ns crystal clock cycles; see Fig. 3.7.

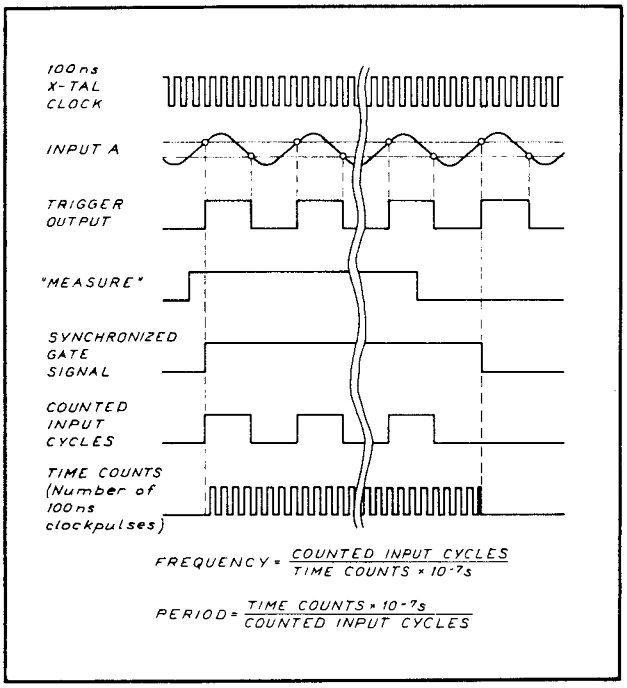


Fig. 3.7. Input synchronized mode.

The resolution in the input synchronized mode, is caused by truncation of the clock pulses, which results in a ±1 clock pulse error (100ns). The resolution of the measurement thus only depends on the measuring time, e.g. the resolution for 1s measuring time is 10^{-7} (100ns/1s) independent of frequency.

In conventional counters, the gate time is synchronized with the clock signal. The first and last input cycle, can therefore be truncated, causing a ±1 cycle error. This results in a good resolution for high frequency measurements, but a poor resolution for low frequency measurements ($\pm$1/frequency for 1s measuring time).

A RPM measurement is in fact a normal frequency measurement, but the microcomputer multiplies the frequency for 60 before displaying the result.

Measuring time

The measuring time can be varied in 33 steps per decade between 10ms and 96s. Set measuring time can be displayed by pushing the measuring time rotary knob. This resets the counter and a new measurement will start. The counter continues to totalize input cycles until the set measuring time has elapsed and the synchronization conditions are met. Hence, the effective measuring time (also called gate time) is longer than the set measuring time.

The number of cycles (N) is:

$$N = \frac{\text{effective measuring time}}{\text{period duration}}$$

rounded to the nearest higher multiple of 10 for frequency measurements or higher integer for period measurements.

When the measuring time has elapsed, the microcomputer calculates the measuring result with a 10-digit resolution. However, the number of digits displayed, is limited only to the significant digits, depending on the measuring resolution. This measuring resolution is defined by the input frequency and the measuring time.

The number of digits is selected in such a way that the measuring resolution is equal to 0.2...2 units of the least-significant digit (LSD), where:

$$LSD = \frac{2.5 \times \text{Frequency}}{\text{Measuring time} \times 10^7 \text{Hz}} \quad \text{or} \quad \frac{2.5 \times \text{Period}}{\text{Measuring time} \times 10^7 \text{Hz}}$$

rounded to the nearest decade.

Ratio Measurements

The counter measures the frequency ratio between signals connected to input A and input B. The frequency range is 0...10MHz.

To obtain full input frequency range on PM 6671...72, a ratio measurement can be done in the FREQ A or C mode. Connect the signal with the highest frequency to input A (0.1Hz...120MHz) and the other signal to input D set to EXT STD IN. The frequency range at input D is 50kHz...10MHz. However, this arrangement does not give correct setting of the decimal point. The display will indicate a frequency. To get the correct ratio, divide the displayed value by 10^7 Hz, e.g. when the display shows 215.513MHz, it represents a ratio of 21.5513.

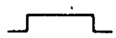
A ratio measurement is useful, for instance, when calibrating oscillator with an awkward frequency. For example, say that the fequency should be 4.3625872MHz. This is difficult to read on the display. By connecting such a reference signal to input B and measuring the ratio instead, the oscillator is correctly calibrated when the display shows 1.0000000, which is much easier to read.

Count measurements

There are three different count modes:

Manual — The counter totalizes events at input A, during the time interval between releasing and depressing the DISPL HOLD pushbotton. An event is defined as a positive-going slope.

Gated by B — The counter totalizes events at input A, between the leading and trailing edge of the input B signal.



Start and stop by B — The counter totalizes events at input A, between the start and stop event at input B.

Time interval single measurements

In the time interval single mode, the time (i.e. number of 100ns clock pulses) is measured between a start event at channel A and a stop event at channel B. The start and stop triggering can be individually set with respect to coupling, trigger level, slope and attenuation (x1 or x10).

To perform single source measurements, such as rise-time and pulse width, only channel A has to be connected. The input B connector is disconnected. However, channel B is internally connected by means of the COM via A pushbutton. In this case, the coupling and attenuation of channel B are disconnected (identical as for channel A). The trigger level and slope in channel B can still be set independently of the channel A setting. The resolution of the measurement is $\pm$ 1 clock pulse ($\pm$ 100ns).

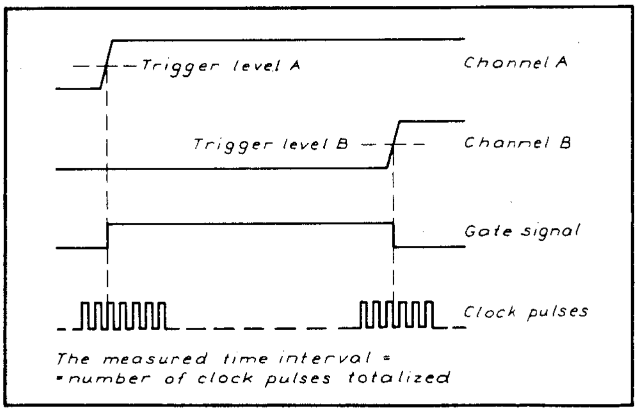


Fig. 3.8. Time interval single mode.

Time interval average measurements

By using the time interval average technique, which means multiple measurements of a repetitive signal, the measuring accurancy and resolution are greatly improved. Compared to single time interval measurements, the basic 100ns resolution is improved by a factor of $1/\sqrt{N}$, where N is the number of time intervals being averaged.

$$N = \frac{\text{Measuring time}}{\text{Pulse repetition time}}$$

When using time interval average, the number of leading edges of the clock pulses occurring in each individual "time window" are totalized. Figure 3.9. illustrates a rise-time measurement.

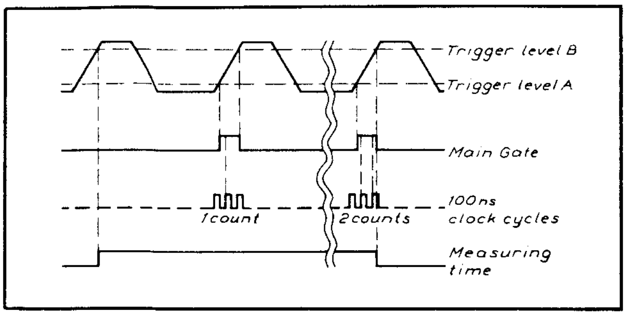


Fig. 3.9. Time interval average mode.

For a signal as illustrated in Fig. 3.9, approx 10000 time intervals are being averaged during a measuring time of 10ms. Let's say that 6000 are measured as 200ns (2 clock cycles) and 4000 as 100ns. The statistical average is calculated in the microcomputer. In this case the average is 160ns. The resolution is 100 ns/ $\sqrt{10000}$ = 1ns. Note that the input signal must be repetitive and asynchronous with respect to the time base and that the minimum dead time from stop to start is 300ns.

Pulse width measurements

These measurements are similar to single time interval measurements. Both start and stop triggering takes place in channel A, with common trigger level setting and automatic trailing edge trigger slope inversion with respect to selected leading edge trigger slope.

Phase delay measurements

The timer/counters PM 6670...72 can measure the phase delay between two signals connected to input A and B. The measurement is performed as a simultaneous measuring of time interval A-B and period.The phase delay is calculated as:

$$\text{Phase delay} = \frac{\text{Time Interval A-B}}{\text{Period}} \times 360^\circ$$

The measurement is made as an average measurement to improve accuracy and resolution; see Fig. 3.10.

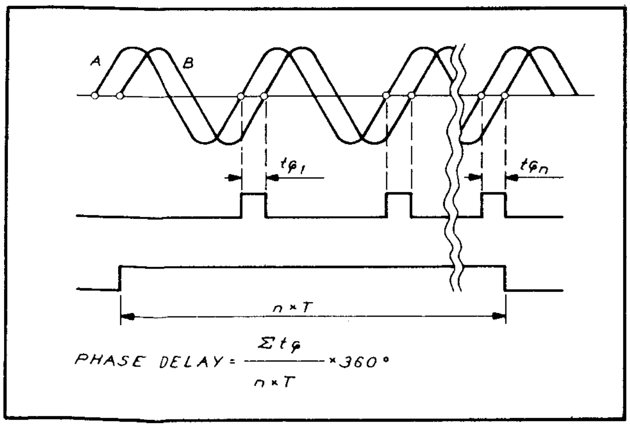


Fig. 3.10. The phase delay measurement.

In order to get a high accuracy phase delay time interval measurement, the setting of the trigger level is very important. The trigger levels should be identical for both channels and as close to zero as possible. This is normally achieved with AC coupling and max sensitivity setting. Unequal settings of the trigger levels will result in inaccurate time interval measurements; see Fig. 3.11.

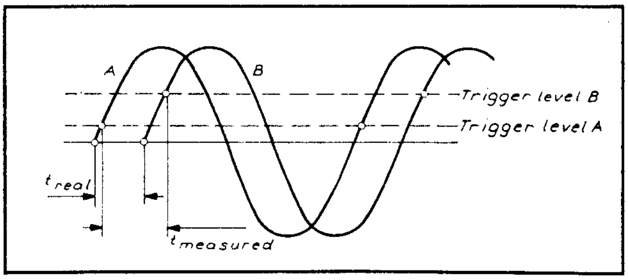


Fig. 3.11. Unequal settings of the trigger levels will result in inaccurate time interval measurements.

Very large differences in slew rate between the signals, can result in a systematic phase error, which can be up to 3...5°. This is caused by the hysteresis band (typically ±10mV). Although the trigger level is set to 0mV, the actual trigger point will be +10mV. With variations in slew rate, the time before crossing the +10mV limit will vary; see Fig. 3.12.

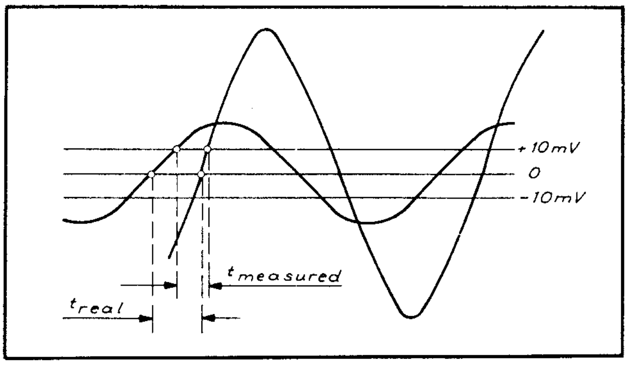


Fig. 3.12. Varitation in slew rate can result in phase error.

It is therefore important to keep the signals at about equal amplitude (sine and triangular waves). Since a normal time interval average measurement is made, we also have the normal restriction concerning minimum dead time between stop and start of the time interval, i.e. 300ns. the dead time also determines the maximum signal frequency, which is 1.6MHz.

Duty cycle measurements

A duty cycle measurement can be made by means of a phase measurement. Connect the signal to Input A, push COM via A and SLOPE for Input B. However, the displayed read-out will be in degrees. Divide the result by 3.6 to get 0...100% or by 360°to get 0...1 (duty factor). If the counter is equipped with a PM 9696 IEC-625/IEEE-488 bus interface, this calculation could easily be done by the controller.

SPECIAL FUNCTIONS

Arming

Arming enables the counter to be prevented from starting on unwanted signals. The external ARMING input (input E on the rear panel) allows an additional trigger condition. When input E is set to high logic level ($>$ 2V), the counter is prevented from starting a new measurement. However, the counter makes all preparations for a measurement. When input E returns to low ($<$ 0.5V), the measurement will start with a minimum of delay. The delay is approx 0.5μs.

Note that arming cannot be used in the COUNT A manual mode.

External reset

Electrical reset, provides an equivalent function to the front panel reset pushbutton. The counter is reset when input E is set to high logic level ($>$2V). A new measurement can be made when input E has returned to low ($<$ 0.5V).

Single burst frequency measurements

The input synchronized counter is in general suitable for burst frequency measurements. The frequency measurement does not start until the burst has arrived, because the opening of the main gate is controlled by the input signal. However, there are some restrictions:

- The set measuring time must be shorter than the burst duration.
- The burst must contain at least 20 cycles.
- The minimum measuring time is 10ms.

Multiple burst frequency average

PM 6671 and PM 6672 are equipped with an external gate function, permitting the counter to make burst measurements down to 500ns. The external gate control signal should be connected to input E (Set to FREQ AVERAGE) for controlling the multiple burst frequency average function. The measurement is interrupted when input E is higher than 2V. The external gate time can be down to 500ns. The actual measuring time is the sum of all individual gate openings made during the set measuring time.

Note that the burst must contain at least 10 cycles during the time input E is low and 10 cycles after input E has returned high, as shown in Fig. 3.13.

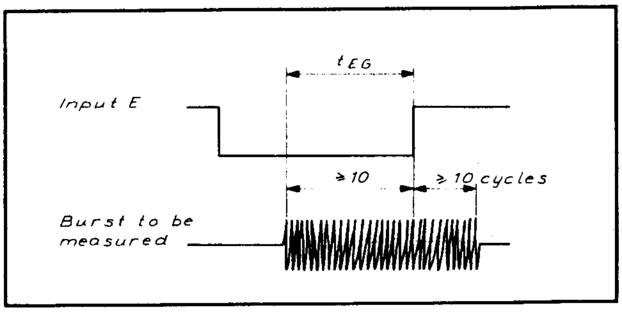


Fig. 3.13. Burst requirements for multiple burst frequency average.

A monostable flip-flop or a pulse generator with external triggering (e.g. PM 5716) could be used, see Fig. 3.14. It is also possible to measure a single burst by means of the input E control.

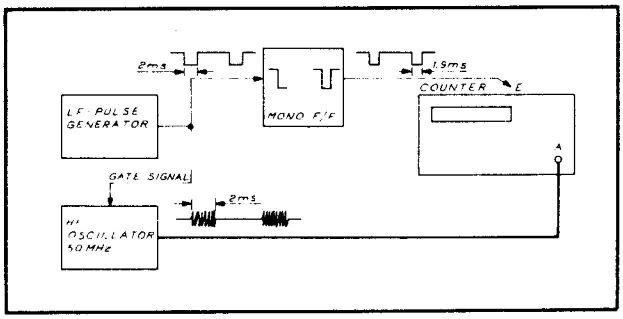


Fig. 3.14. Example of a measurement set-up for multiple burst frequency average.

The difference in propagation delay in the two internal channels in the counter-on-a-chip is approx 15ns. In FREQ AVERAGE mode with very short external gate times, this delay will cause a measureable error as the 15ns will be repeated for each external gate pulse. However, it is possible to compensate for this error. Measure a stable, continuous wave of approx the same frequency in the normal mode without external gate signal with an external gate signal having the same number of samples and the same gate duration as will finally be used (measured value = F2). To compensate for the error obtained in the frequency average mode, multiply the reading with the factor K = F1/F2.

The total relative error for a multiple frequency average measurement is:

$$\text{Rel.error} = \pm \frac{15\text{ns}}{t_{EG}} \pm \frac{100\text{ns} \pm \text{trigger error}_{EG} \pm \text{trigger error}_{A}}{t_{EG}\sqrt{N}} \pm$$

$$\pm \text{ rel. time-base error}$$

where t_{EG} = external gate duration

N = number of burst samples.

Hold-Off

PM 6671 is equipped with trigger hold-off, which avoids false stop triggering on spurious or unwanted signals. A typical example is the pulses from relay contact bounce, as illustrated in Fig. 3.15.

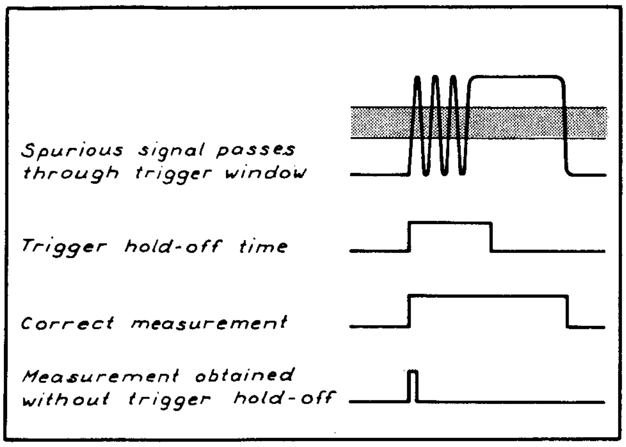


Fig. 3.15. Hold-off avoids false triggering.

Gate monitor

PM 6671 and PM 6672 are equipped with a gate monitor output. By connecting an oscilloscope to this output, it is possible to look at the gate open signal. Figure 3.16 is an illustration of the gate monitor function. Note that the gate open signal is longer than the set measuring time due to the synchronization time.

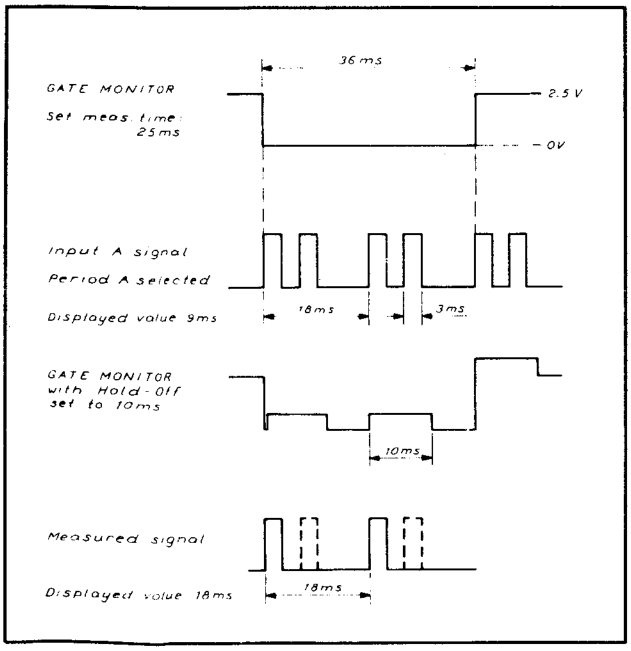


Fig. 3.16. An illustration of the gate monitor function, with and without hold-off.

Practical Measurements

Preliminary settings

1. Before connecting the counter to the line, check that the line voltage selector is correctly set.
2. Set the slide switches on the rear panel to INT STD and EXT RESET (or ARMING).
3. Release all pushbuttons, as necessary.
4. Press POWER ON.
5. Set HOLD OFF to 0 (PM 6671).
6. Set MEASURING TIME to approx 0.1s.
7. Set the SENSITIVITY controls fully clockwise and pulled (AC mode).

Frequency measurements

1. Make the preliminary settings.
2. Select FREQ.
3. Connect the signal to be measured to Input A if the frequency is between 10Hz...120MHz.
4. Decrease the sensitivity until no triggering at all occurs. Push ATT x10, as necessary.
5. Increase the sensitivity again, until the GATE LED is flashing and a stable reading is obtained.
6. For improved triggering on noisy LF-signals, use the low-pass filter.
7. Set the measuring time to give optimum resolution and measurement speed.
8. PM 6672 only:
   If the frequency of the signal to be measured is higher than 120MHz, input C must be used. The frequency range for input C is 70MHz...1GHz. Press pushbutton C (1GHz) to select input C. The sensitivity is automatically adjusted for input C, thus facilitating perfect triggering under most conditions. Maximum allowed voltage at input C is $12V_{RMS}$.

Period measurements

1. Make the preliminary settings.
2. Select PERIOD A.
3. Connect the signal to be measured to Input A.
4. Decrease the sensitivity until no triggering at all occurs. Push ATT x 10, as necessary.
5. Increase the sensitivity again, until the GATE LED flashes and a stable reading is obtained.
6. For improved triggering on noisy LF-signals, use the low-pass filter.
7. Set the measuring time to give optimum resolution and measurement speed.

Count measurements

There are three different count modes:

Manual — The counter totalizes events during the time interval between realising and depressing the DISPL HOLD pushbutton. An event is defined as a positive-going slope.

Gated by B  — The counter totalizes events at input A, between the leading and trailing edge (SLOPE released) of the input B signal.

Start – stop by B  — The counter totalizes events at input A, between the start and stop event at input B.

1. Make the preliminary settings.
2. Select the appropriate COUNT mode.
3. Connect the signal to be counted to input A.
4. Depending on the shape of the input signal, use either AC mode or push the trigger level control for input A (DC mode) and set the trigger level approx to half the amplitude of the signal to be counted.
5. Connect the control signal (if used) to input B.
6. Set the trigger level/sensitivity control for input B to suit the control signal (if used).
7. At 10^8 counted events, the display is full. When further events are totalized, truncation of the LSD starts and the unit indicator now indicates exponents. If the µs/kHz indicator glows read 10^3 pulses, for ms/MHz read 10^6 pulses and for s/GHz read 10^9 pulses.

Time interval measurements

There are two modes for measuring time intervals.

Single: The counter measures the time interval between a start event at input A and a stop event at input B.

Average: The counter measures the time interval average of a repetitive signal that is not synchronized with the used time-base.

1. Make the preliminary settings.
2. Select TIME INT single A-B or average A-B.
3. Connect the signals to input A and input B.
4. When measuring time intervals on a single channel, connect the signal to input A and push COM via A.
5. Push the trigger level control (DC mode) and select correct trigger level, e.g. 50% of the signal amplitude for measuring pulse width or 10% and 90% for measuring rise-time.
6. Select correct trigger slopes.
7. Time interval average only:
   Set the measuring time to give optimum resolution and measurement speed.

Hold-Off (PM 6671 only)

To avoid false stop triggering on spurious or unwanted signals, the hold-off function could be used. To display the set hold-off time, select TIME INT SINGLE A–B and push CHECK.

Ratio measurements

1. Make the preliminary settings.
2. Select RATIO A/B.
3. Connect the signals to input A and input B. The frequency range is 0...10MHz.
4. Decrease the sensitivity until no triggering at all occurs.
5. Increase the sensitivity again, until a stable reading is obtained.
6. Set the measuring time to give optimum resolution and measurement speed.

To obtain full frequency range on PM 6671...72, a ratio measurement can be made in the FREQ A or C mode:

1. Make the preliminary settings.
2. Select FREQ A or C.
3. Connect the signal with the highest frequency to input A or input C (PM6672).
4. Connect the other signal to input D and set the switch to EXT STD IN. Note that the frequency range at input D is 50kHz...10MHz.
5. Set the sensitivity for channel A.
6. Set the measuring time to give optimum resolution and measurement speed.
7. Divide the displayed value by 10^7 (10MHz) to obtain the correct ratio.

Phase delay measurements

1. Make the preliminary settings.
2. Select PHASE A–B.
3. Connect the signals to input A and input B.
4. The input voltages must exceed $100mV_{RMS}$
5. If any of the input voltages exceeds $2V_{RMS}$, push ATT x10 for the appropriate channel.
6. Do not change the sensitivity setting.
7. Try to obtain approx the same signal amplitude to both inputs. Use ATT x10 or an external attenuator (preferable resistive) if necessary.
8. Do not use oscilloscope probes as they introduce extra phase delays.
9. Invert the trigger slope for channel B when measuring phase angles around 0^o , thus 180^o will be added. Unstable readings caused by phase-jitter are now avoided.
10. Set the measuring time to give optimum resolution and measurement speed.

Pulse width measurements

1. Make the preliminary settings.
2. Select PULSE WIDTH A.
3. Connect the signal to input A.
4. Push the trigger level control (DC mode) and set the trigger level to 50% of the signal amplitude.
5. Select SLOPE, i.e. released for positive pulse width and pushed for negative pulse width.
6. Pulse width measurements can also be performed in the time interval mode, but require more control settings. However, pulse width below 1μs should be made in the time interval average A–B mode.

Check mode

1. Make the preliminary settings.
2. Press CHECK. The internal 10MHz time-base signal is now connected to the logic circuits and all input controls are disconnected.

CHECK enables a self-test of most measuring functions. The resolution is given by the set measuring time (not applicable for pulse width and time interval single mode).

Note:

- RPM will give overflow condition, i.e. 9.9.9.9.9.9.9.9.
- CHECK cannot be used for checking phase delay, as the internal clock frequency is higher than 1.6MHz.
- Checking of COUNT A gated by B or start/stop by B is not possible.
- PULSE WIDTH will display 0, TIME INTERVAL Single 100ns and TIME INTERVAL Average 50ns.
- FREQ C (PM 6672) will display 256, i.e. the prescaling factor.

Overflow condition

An attempt to divide by zero (in ratio A/B mode) or effective measuring times longer than 99s will result in an overflow condition.

The display will show: 9.9.9.9.9.9.9.9.

4. Performance Check

Required Test Equipment

- Voltmeter, e.g. Philips PM 2517
- Frequency counter, e.g. Philips PM 6650
- Oscilloscope, e.g. Philips PM 3215
- Sampling oscilloscope, e.g. Philips PM 3400
- Pulse generator, e.g. Philips PM 5771
- Function generator, e.g. Philips PM 5131
- HF signal generator, e.g. Wavetek 2002A
- Probe, 10Mohm, 120MHz
- FET probe, e.g. PM 9354
- T-piece, BNC-type
- Temination, 50ohm, BNC-type

Initial set-up

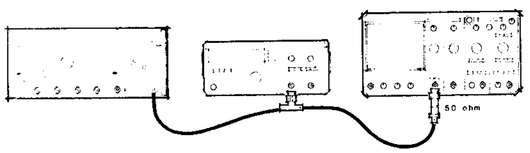
All pushbuttons should be in a realeased position. Set MEASURING TIME to 10ms (fully anticlockwise) and HOLD OFF (PM 6671) to 0 (off). Pull both TRIGGER LEVEL/SENSITIVITY potentiometers (i.e. AC mode) and turn them fully clockwise. Select FREQ A. The slide switches on the rear panel should be set to INT STD and EXT RESET (not applicable to PM6670). Set the line voltage slide switch on the rear panel to the local line voltage. Connect the counter to the line and press POWER ON.

Check of the oscillator

The /01 version of PM 6670...72 can be checked by connecting the 10 MHz OUT from a counter, e.g. a PM 6650 or a PM 6673 equipped with at least a calibrated TCXO, to connector D on the rear panel via a 10 Mohm probe. The frequency should be 10 MHz ± 10Hz.For /02.../05 versions, please refer to Section, Optional Oscillators in the service manual.

Check of the sensitivity and frequency response

- Connect a signal generator and an oscilloscope via a T-piece to input A.

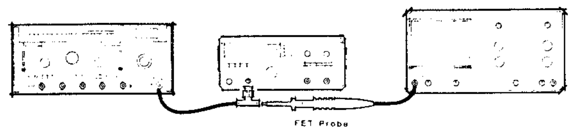


- Use short 50ohm coaxial cables. If the signal generator has a 50ohm output impedance, a 50ohm termination has to be used at the oscilloscope. The termination should not be used with a sampling oscilloscope (above approx 25MHz).
- Check the sensitivity at the following frequencies:

  50Hz...75MHz : 25mVpp
  75...120MHz : 50mVpp

Check of Input C (PM 6672 only)

- Connect a RF signal generator and a sampling oscilloscope via a T-piece to input C. Use a FET probe on the oscilloscope.



- Set the amplitude to 15mV$_{RMS}$ (−24 dB) and vary the frequency between 70 MHz and 800 MHz. The counter should measure correctly.
- Set the generator to 1GHz with 25mV$_{RMS}$ (−19dB) amplitude. Check that the counter displays a correct value.
- Push CHECK.
- Adjust the measuring time and check the display read-out as follows.

Measuring time	*Display read-out*
10ms	0.25600GHz
100ms	256.000MHz
1s	256.0000MHz
1.5s	256.00000MHz

- Release CHECK.

Check of TRIGGER LEVEL
(PM 6671 and PM 6672)

- Push both TRIGGER LEVEL potentiometers.
- Connect a DMM to the trigger level output connector for input A on the front panel.
- Vary the trigger level between both end positions.
- Check that the voltage can be adjusted between −2.5 and +2.5V with a tolerance of 0.15V.
- Repeat the procedure for input B.
- Pull both TRIGGER LEVEL potentiometers and set them fully clockwise.

Check of COUNT A MANUAL

- Push CHECK.
- Select COUNT A MANUAL.
- Push DISPL HOLD and then RESET. Check that the display read-out is 0 and the GATE LED is off.
- Release DISPL HOLD. The counter should start counting and the GATE LED start blinking.

- Push DISPL HOLD. The counting should stop.
- Release DISPL HOLD. The counting should start from the accumulated value.
- Count 10^8 pulses (takes approx 10s) and press DISPL HOLD. the decimal point to the right of the 6:th decade should light. The ms/MHz LED should also light, indicating that the result should be multiplied by 10^6
- Push RESET and release DISPL HOLD.

Check of COUNT A Gated by B

Note: The instructions for checking Count, Pulse Width and Time Interval are written in such a manner that the checks should be made in sequence.

- Select COUNT A Gated by B
- Connect 10MHz OUT from e.g. a PM6650 to input A and TIME-BASE OUT to input B. The PM 6650 should be set to PERIOD A with a 1us time base.
- Release CHECK.
- The display read-out should be 6.
- Push SLOPE for input B. The display read-out should be 4.
- Release SLOPE for input B.

Check of COUNT A Start/Stop by B

- Select COUNT A. Start/Stop by B
- The display read -out should be 10. Push SLOPE for input A if necessary due to the internal phase condition in the LSI counter-ona-chip.
- Release SLOPE for input A.

Check of PULSE WIDTH A

- Select PULSE WIDTH A.
- Remove the cable from input A. Shift the cable from input B to input A.
- The display read-out should be 0.0006 ± 0.0001ms.
- Push SLOPE for input A. The display read-out should be 0.0004 ±0.0001ms.
- Release SLOPE for input A.

Check of TIME INT SINGLE A–B

- Select TIME INT SINGLE A–B.
- Push COM via A and SLOPE for input B.
- The display read-out should be 0.0006 ± 0.0001ms.
- Push SLOPE for input A and release SLOPE for input B.
- The display read-out should be 0.0004 ± 0.0001ms.

Check of TIME INT AVERAGE A–B

- Select TIME INT AVERAGE A–B.
- Set the measuring time to 1s. The display read-out should be approx 400ns.
- Release SLOPE for input A and push SLOPE for input B. The display read-out should be approx 600ns
- Remove the cable from input A.

Check of RPM

- Select RPM A.
- Connect a 50Hz, 500mVpp square-wave to input A.
- The display read-out should be approx 3000.

Check of PERIOD A, FREQ A and RATIO A/B

- Select required function and push CHECK.
- Adjust the measuring time and check the display read-out as follows.

MEAS. TIME	*PERIOD A*	*FREQ A*	*RATIO A/B*
10ms	100.000ns	10.0000MHz	1.00000
100ms	100.0000ns	10.00000MHz	1.000000
1s	100.00000ns	10000.000kHz	1.0000000

- Release CHECK.

Check of PHASE

- Select PHASE A–B. Push COM via A and SLOPE for input B.
- Connect a 1.6MHz, 100mVpp sine-wave to input A.
- The display read-out should be 180° ± 3° .
- Push SLOPE for input A and release SLOPE for input B.
- The display read-out should be 180° ± 3° .
- Release SLOPE for input A.

Check of HOLD OFF

- Select TIME INT SINGLE A–B and push SLOPE for input B.
- Connect a 50Hz, 100mVpp square-wave to input A.
- The display read-out should be 10ms.
- Turn the HOLD OFF potentiometer slowly clockwise, until the display read-out is 30ms.
- Push CHECK. The Hold-Off time should be approx 10ms.
- Reset HOLD OFF to 0. Release COM via A, SLOPE for input B and CHECK.

Check of the low-pass filter

- Push the 50kHz FILTER button.
- Connect a 1MHz sine-wave to input A. Check that the counter requires a signal amplitude ≧ 40dBm (20x) higher than without filter.

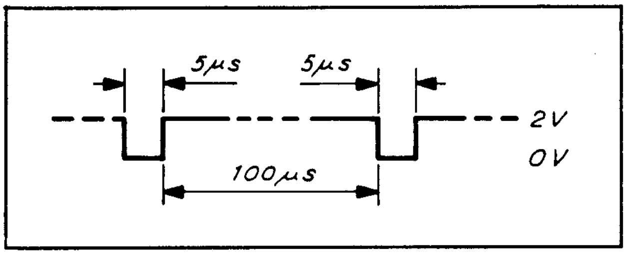
Check of the dead-time between stop and start

- Select PULSE WIDTH A.
- Push COM via A and SLOPE for input B.
- Connect a pulse generator to input A and adjust the output to 1MHz with 0.8V amplitude.

- Set the pulse width to approx 0.4us and increase the frequency slowly until the counter starts to display an incorrect pulse width.
- Push SLOPE for input A and release SLOPE for input B. The dead-time should be less than 0.3μs.
- Release COM via A and SLOPE for input A.

Check of FREQUENCY AVERAGE

- Select FREQ A.
- Set slide switch E on the rear panel to position FREQ AVERAGE.
- Connect a 120MHz sine-wave with 50mVpp amplitude to input A.
- Set the measuring time to 1s. The display read-out should be 120.XXXXX MHz.
- Connect the signal below to input E.

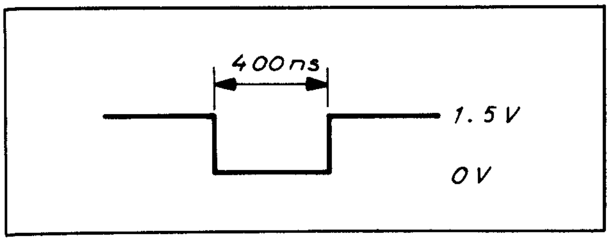


- The display read-out should be 120.XXX MHz.
- Note that the result now is approx 0.2% higher.
- Reset slide switch E to EXT RESET.

Please refer to Section, Theory of Measurements for more information about frequency average measurements.

Check of EXT RESET and ARMING
(PM 6671 and PM 6672)

- Select PERIOD A.
- Set the measuring time to 1.0s.
- Connect a DC voltage of +0.5V to input E and check that the counter is not reset; apply +1.0V and check that the counter resets.
- Push DISPL HOLD.
- Connect single-shot, positive pulses with +1.5V amplitude and 180μs duration to input E.
- Check that the counter makes a measurement for each single-shot.
- Release DISPL HOLD.
- Set the slide switch to position ARMING.
- A DC voltage of +0.5V connected to input E should not arm the counter, but +1.5V should (the GATE LED stops blinking).
- Single- shot pulses, as illustrated below, should make the GATE LED blink for each pulse.



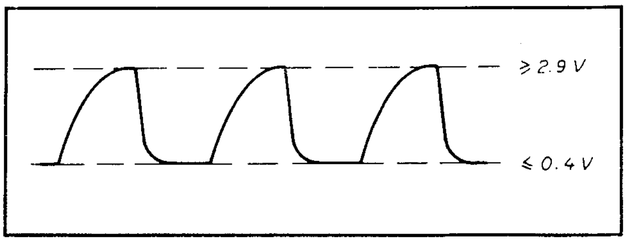
- Remove the signal form input E and set the slide switch to position EXT RESET.

Check of EXT STD IN

- Select FREQ A and push CHECK.
- Set the slide switch for connector D on the rear panel to position EXT STD IN.
- Connect a 10MHz, 1Vpp sine-wave via a 50ohm termination and a BNC T-piece to connector D.
- Measure the amplitude with a 10Mohm probe via the T-piece.
- Check that the Gate indicator LED blinks and that the display read-out is 10.0000MHz at a measuring time of 10ms.
- Set the frequency to 10kHz.
- Check that the Gate indicator LED blinks and that the display read-out is 0.0100MHz.
- Reset the slide switch to INT STD OUT.

Check of INT STD OUT

- Connect an oscilloscope via a 10Mohm probe to the INT STD OUT connector on the rear panel.
- Voltage levels are illustrated below.



Check of GATE MONITOR
(PM 6671 and PM 6672)

- Connect an oscilloscope to the GATE MONITOR output on the rear panel.
- Check that the signal is correct. As it is difficult to get a steady display on an oscilloscope, only a schematic illustration of the display is given.